Relevance of CalCOFI to ecosystem science

NOAA FISHERIES SWFSC

CCLME-2.1
Sam McClatchie
NOAA lead for the CalCOFI program

TOR questions addressed:

4. What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the center developed strategies to obtain and manage such data?

7. Are the centers ecosystem-related science products adequately peer-reviewed relative to their purpose and use?

8. Does the center appropriately communicate research results and resource needs to conduct ecosystem-related science to various managers, partners, stakeholders and the public?

CalCOFI is a fisheries oceanography program with ecosystem monitoring goals that are much broader than stock assessment goals.

- The design of CalCOFI is not optimal for estimating fish biomass, because it was designed to map oceanographic surfaces and sections.
- CalCOFI is focused on understanding the long-term changes in the California Current System (physical, biological & chemical).
- This goal is recognized as being intimately linked with basin-scale processes, and CalCOFI has been embedded in larger scale studies of the Pacific since its early days.
- The current focus of the CalCOFI program is now enabled by numerous other programs that piggy-back on and supplement the core survey program.
- CalCOFI provides the second longest marine time series in the world (currently 65 years).

TOR question: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the center developed strategies to obtain and manage such data?

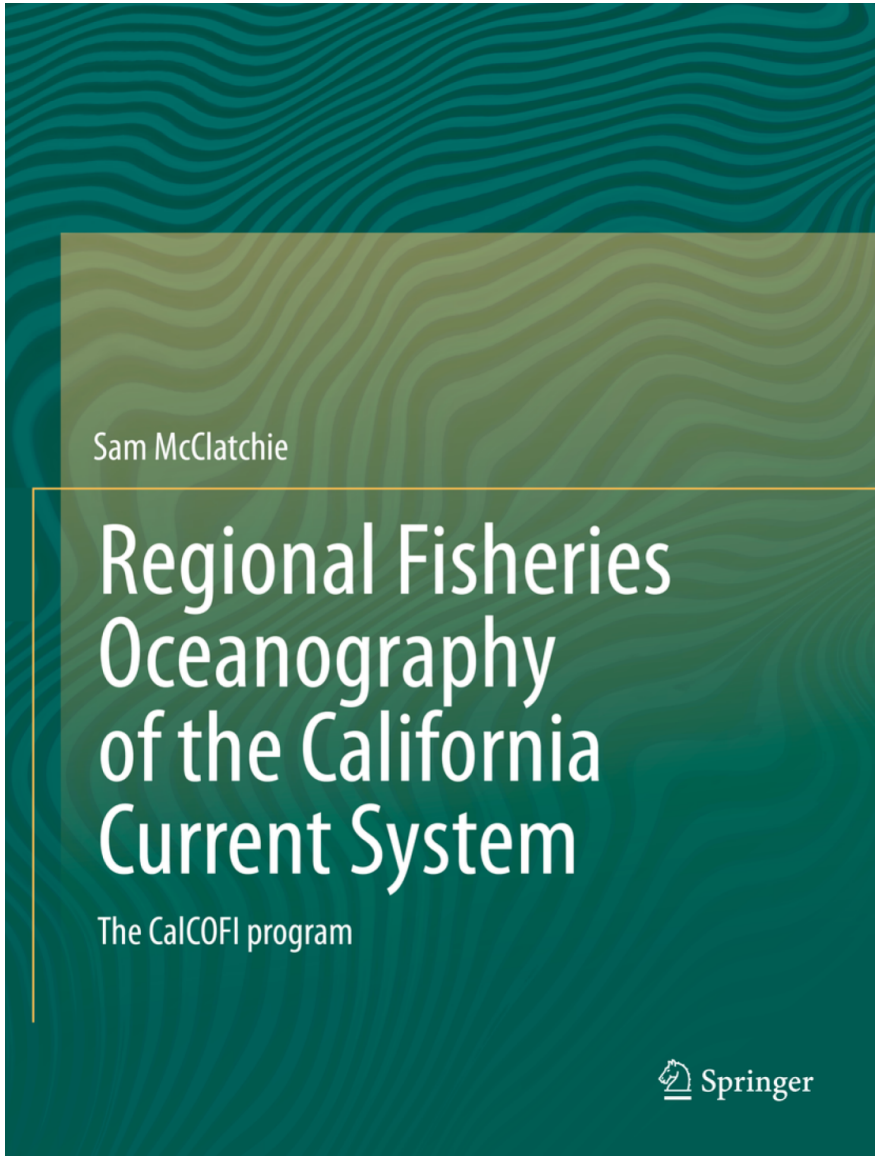
The CalCOFI program was reviewed at SIO in 2010 by an independent panel
Anne Hollowed (AFSC), Anthony Richardson (CSIRO), Bob Cowen (RSMAS, now OSU), Mike Sinclair (BIO), & Enrique Curchitser (Rutgers).

The first recommendation (out of 20) from this panel was that CalCOFI should continue.

The second recommendation was that **"a more complete review paper or book should be prepared to document the major scientific advances that stemmed from CalCOFI monitoring and research"**.

Book references include **600 peer-reviewed publications** (not including biological oceanography, marine mammal and seabird publications!)

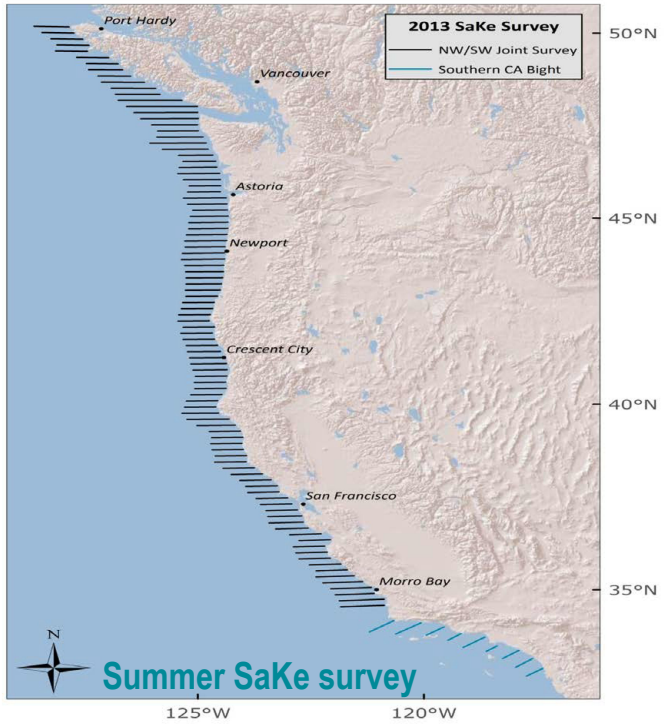
Each year, **CalCOFI Reports publishes the peer-reviewed "State of the California Current" paper**.

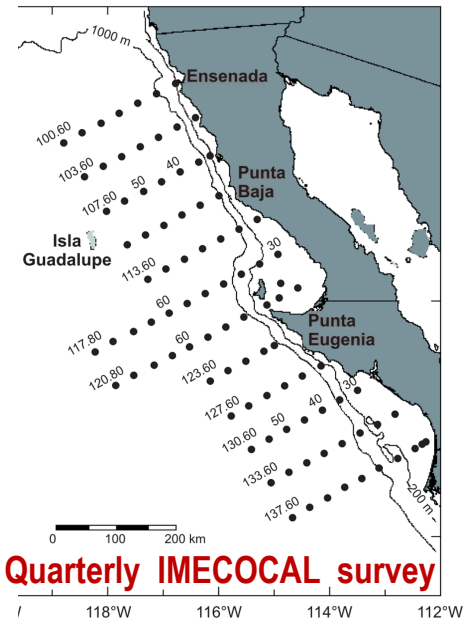


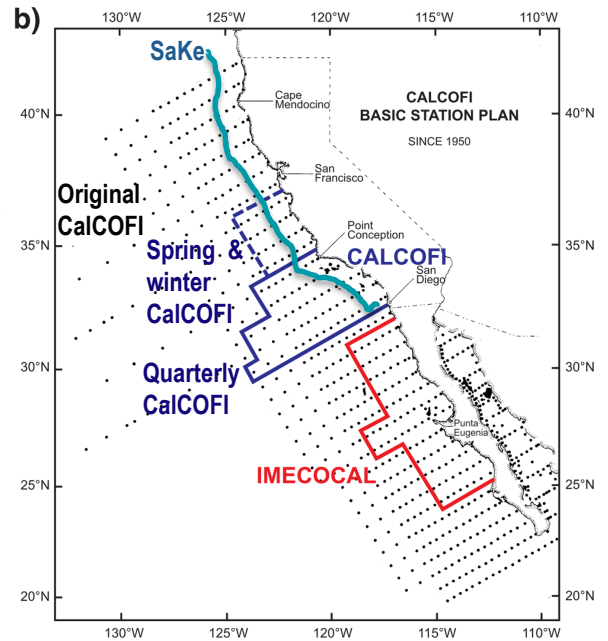
(Published October 2013)

TOR question: Are the centers ecosystem-related science products adequately peer-reviewed relative to their purpose and use?

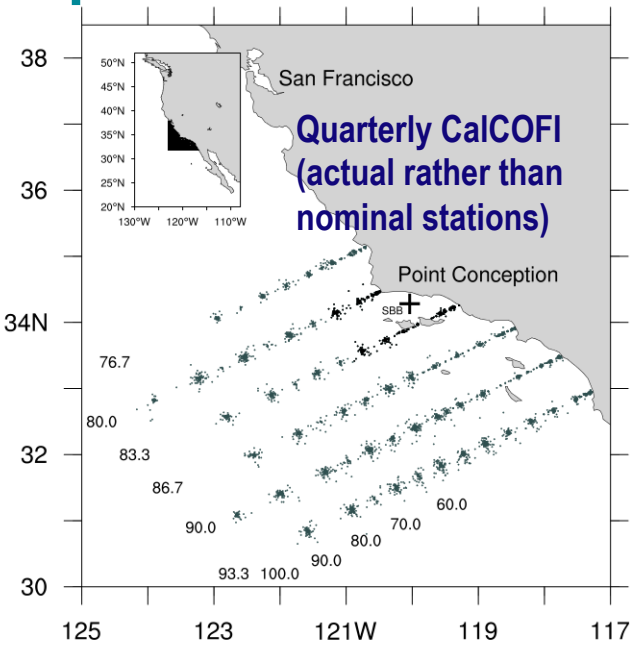
How do the CalCOFI, IMECOCAL and SaKe survey domains compare?

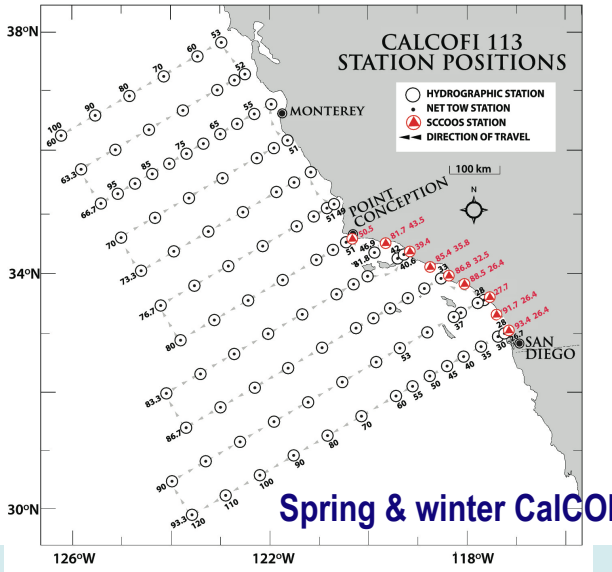






Compare survey domains





TOR question: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs?

Has the center developed strategies to obtain and manage such data?

What ecosystem-related data does CalCOFI measure?

(data directly relevant to assessment are highlighted in red)

- Hydrographic
- Ichthyoplankton and zooplankton
- Primary productivity, fractionations, POC/DOC, DIC
- Acoustics
- Mammal & seabirds

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TOR question: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the center developed strategies to obtain and manage such data?

What ecosystem-related data does CalCOFI measure in more detail?

Hydrographic

CTD Sensors:
- Temperature
- Conductivity
- Oxygen
- Fluorescence
- Transmissomter
- PAR
- pH

Bottle Samples:
- Salinity
- Oxygen
- Nutrients
- Primary Productivity
- Chlorophyll-a
- Phaeopigments
- HPLC
- DIC
- LTER ancillary

Ichthyoplankton & Zooplankton

Nets & CUFES:
- Bongo net, 210m - all stations
- Manta neuston net, all stations
- PRPOOS vertical net, lines 80 & 90, 86.7 & 83.3 coastal only
- Pairovet vertical net, 100m (coastal stations only to 70 m)
- Continuous Underway Fish Egg Sampler (CUFES)

Primary productivity, fractionations, POC/DOC, DIC, Acoustics, Birds and Mammals

Supplementary Data:
- SCS, Underway continuous surface and meteorological measurements
- Primary Productivity, Daily C14-uptake incubations
- Ancillary LTER , Plankton abundance, biomass, Chl a size fractionations, POC, DOC
- Acoustics (5 freqencies)
- DIC, 10 stations: 93.3-30, 90-90, 90-60, 90-53, 90-30, 86.7-35, 81.8-46.9, 80-55, 80-80, 80-90
- Seabirds , Visual Observations
- Cetaceans, Visual and Passive acoustic surveys

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TOR question: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the center developed strategies to obtain and manage such data?

How are CalCOFI data managed?

- Data processing has developed on an “as needed” basis over many years.
- The data system was developed ad hoc rather than using system design.
- Documentation of data processing scripts was done retroactively.
- Until the last 5 years, many datasets were held on individual scientists computers with no consistent data management or backup systems.
- Data process improvement has been limited by hiring restrictions.
- Progress on serving final data has leap-frogged improvement of the post-cruise raw data processing and the CalCOFI database.

TOR question: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the center developed strategies to obtain and manage such data?

The results of the search for CalCOFI

47 matching datasets, with the most relevant ones listed first.

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	WMS	Title	Sum-mary	FGDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution	Dataset ID
	set	data	graph		CalCOFI Cruises		M	background	RSS		NOAA SWFSC	erdCalCOFIcruises
	set	data	graph		CalCOFI Egg Counts Positive Tows		F I M	background	RSS		NOAA SWFSC	erdCalCOFIeggcntpos
	set	data	graph		CalCOFI Egg Stages		F I M	background	RSS		NOAA SWFSC	erdCalCOFIeggstg
	set	data	graph		CalCOFI Fish Counts		F I M	background	RSS		NOAA SWFSC	erdCalCOFIfshcnt
	set	data	graph		CalCOFI Fish Counts Positive Tows		F I M	background	RSS		NOAA SWFSC	erdCalCOFIfshcntpos
	set	data	graph		CalCOFI Fish Sizes		F I M	background	RSS		NOAA SWFSC	erdCalCOFIfshsiz
	set	data	graph		CalCOFI Larvae Counts, Scientific Names AN to AR		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntANtoAR
	set	data	graph		CalCOFI Larvae Counts, Scientific Names AS to BA		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntAStoBA
	set	data	graph		CalCOFI Larvae Counts, Scientific Names A to AM		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntAtoAM
	set	data	graph		CalCOFI Larvae Counts, Scientific Names BCE to BZ		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntBCEtoBZ
	set	data	graph		CalCOFI Larvae Counts, Scientific Names CD to CH		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntCDtoCH
	set	data	graph		CalCOFI Larvae Counts, Scientific Names CI to CO		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntCItoCO
	set	data	graph		CalCOFI Larvae Counts, Scientific Names CP to DE		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntCPtoDE
	set	data	graph		CalCOFI Larvae Counts, Scientific Names C to CE		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntCtoCE
	set	data	graph		CalCOFI Larvae Counts, Scientific Names DH to EC		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntDHtoEC
	set	data	graph		CalCOFI Larvae Counts, Scientific Names ED to EU		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntEDtoEU
	set	data	graph		CalCOFI Larvae Counts, Scientific Names EV to GN		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntEVtoGN
	set	data	graph		CalCOFI Larvae Counts, Scientific Names GO to HA		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntGOtoHA
	set	data	graph		CalCOFI Larvae Counts, Scientific Names HB to HI		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntHBtoHI
	set	data	graph		CalCOFI Larvae Counts, Scientific Names HJ to ID		F I M	background	RSS		NOAA SWFSC	erdCalCOFIlrvcntHJtoID

More data follows in the table, so scrolling down …

	set	data	graph		CalCOFI NOAAHydros		F I M	background	RSS		NOAA SWFSC	erdNOAAhydros
	set	data	graph		CalCOFI SIO Hydrographic Bottle Data		F I M	background	RSS		UCSD SIO	siocalcofiHydroBottle
	set	data	graph		CalCOFI SIO Hydrographic Cast Data		F I M	background	RSS		UCSD SIO	siocalcofiHydroCasts

This information is also available in other file formats (.csv, .htmlTable, .json, .mat, .nc, .tsv, .xhtml) via a RESTful web service.

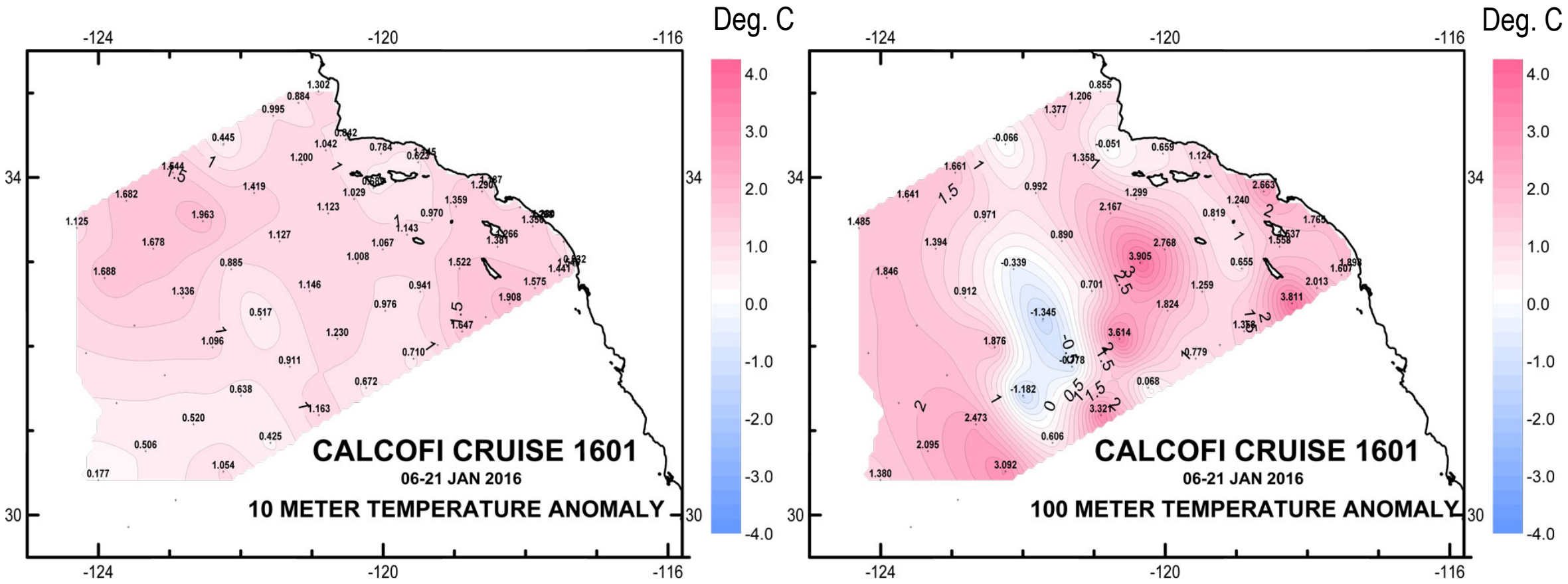
Relevance of CalCOFI to ecosystem science

CalCOFI is used to address ecosystem related questions, such as:

- Example 1. Is it warmer than normal this year?
- This year is supposed to be a monster El Niño. Are we seeing effects similar to 1997/98?
- Example 2. There is increasing hypoxia in the equatorial Pacific. Is it affecting our region?
- What are the spatial patterns and temporal trends in ocean acidification?
- Example 3. Can CalCOFI contribute to environmental data for stock assessments?
- Are there any trends in non-commercial fish species that we should be concerned about?

TOR question: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the center developed strategies to obtain and manage such data?

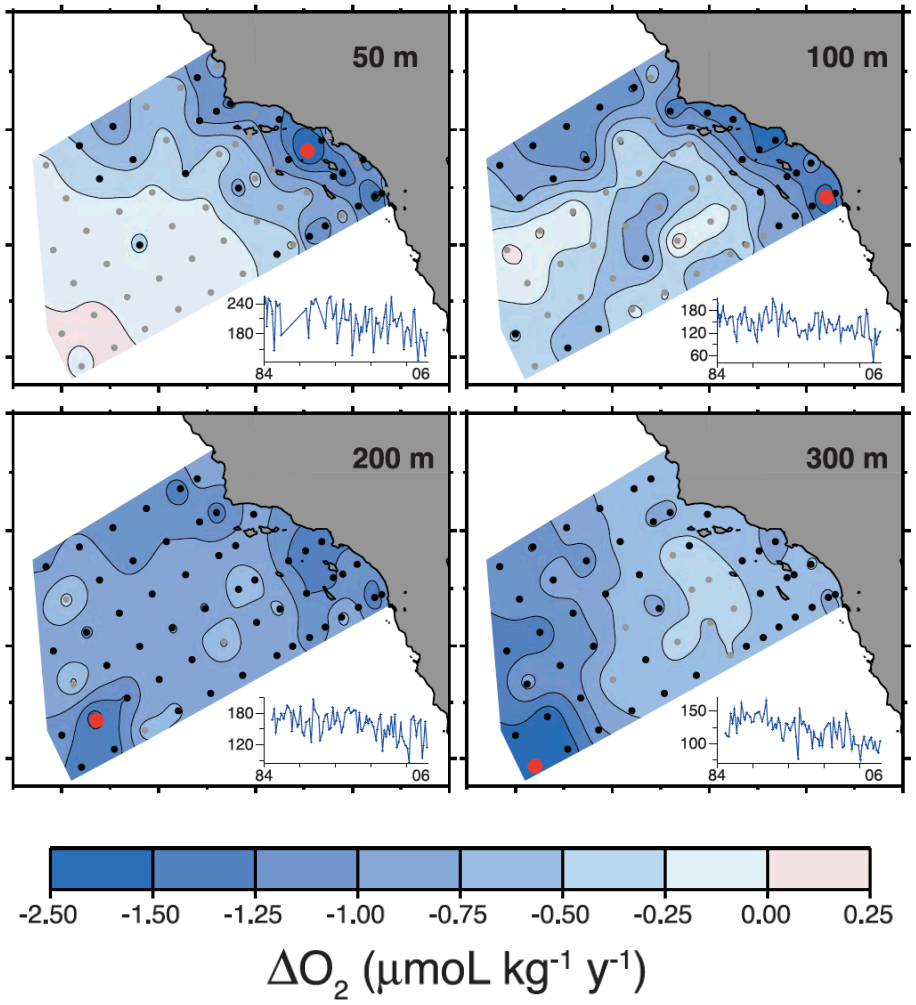
Is it warmer than normal this year?



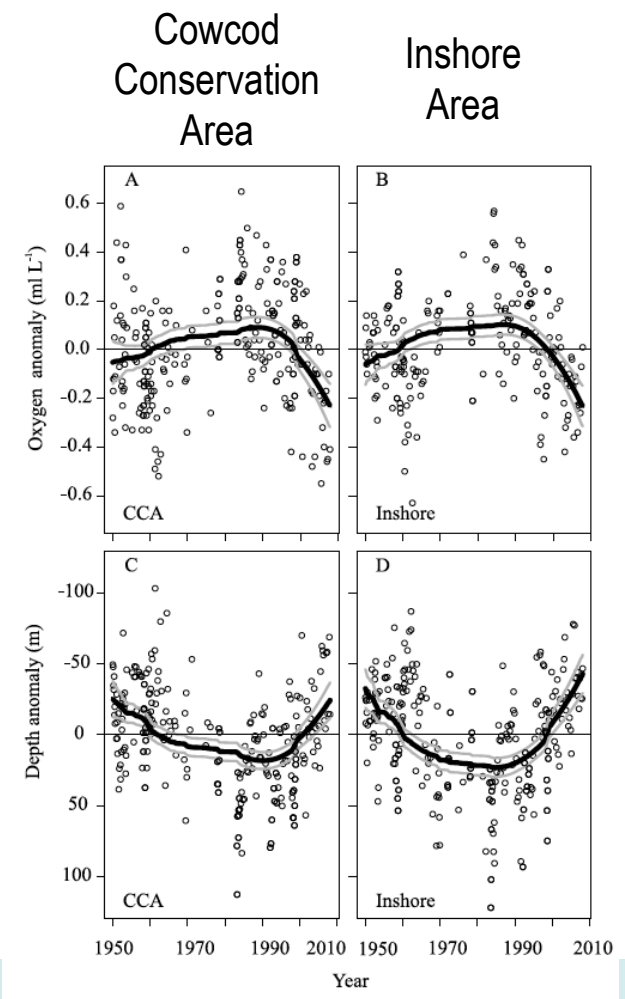
Preliminary surfaces from the recent winter CalCOFI cruises based on CTD cast data show anomalous warming at 10 m and 100 m depths. Results show temperatures up to 4 degrees warmer than the long term mean at 100 m depth.

There is increasing hypoxia in the equatorial Pacific. Is it affecting our region?

(Bograd *et al*. 2008)



(McClatchie et al. 2010)



Trends in oxygen concentration from 1984 (left) and from 1951 (right) show declining oxygen in recent decades (1984-2006).

The longer time series shows that although oxygen is declining in recent years, it is returning to values that were experienced in the 1950s.

Can CalCOFI contribute environmental data for stock assessments?

The Environmental Component of the Sardine Harvest Control Rule

- Most of the variance in the stock-recruit-temperature relationship is explained by stock size.
- Temperature also has a significant effect for the 1981-2010 data (omitting the originally included 1935-1963 data).

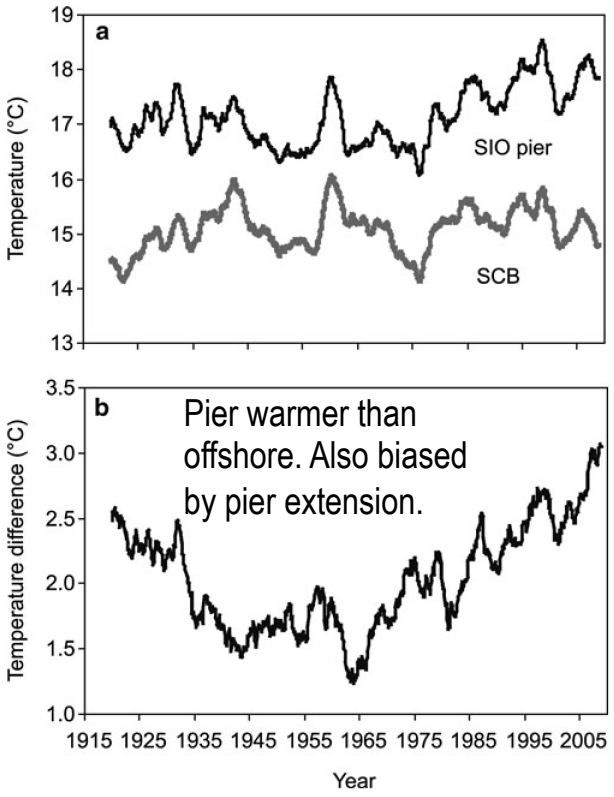
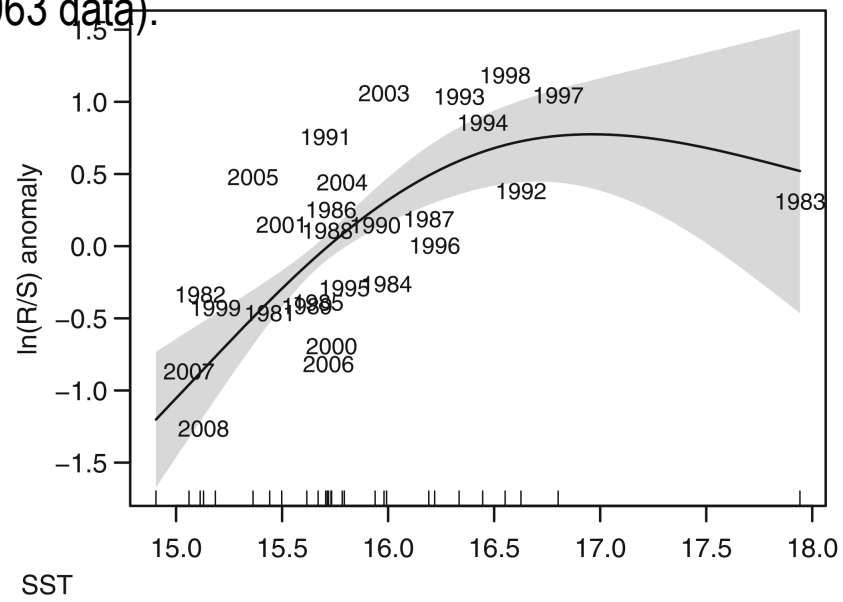
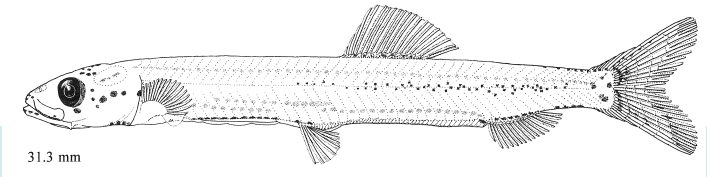


Fig. 6.5 (**a**) Comparison of the 3-year average SIO pier surface temperature with the 3-year average 10 m depth reconstructed temperatures from the 2×2° grid squares in the offshore sardine spawning area of the SCB (**b**) Difference between the two time series calculated as SIO pier temperature – offshore SCB temperature (From McClatchie et al. [369])

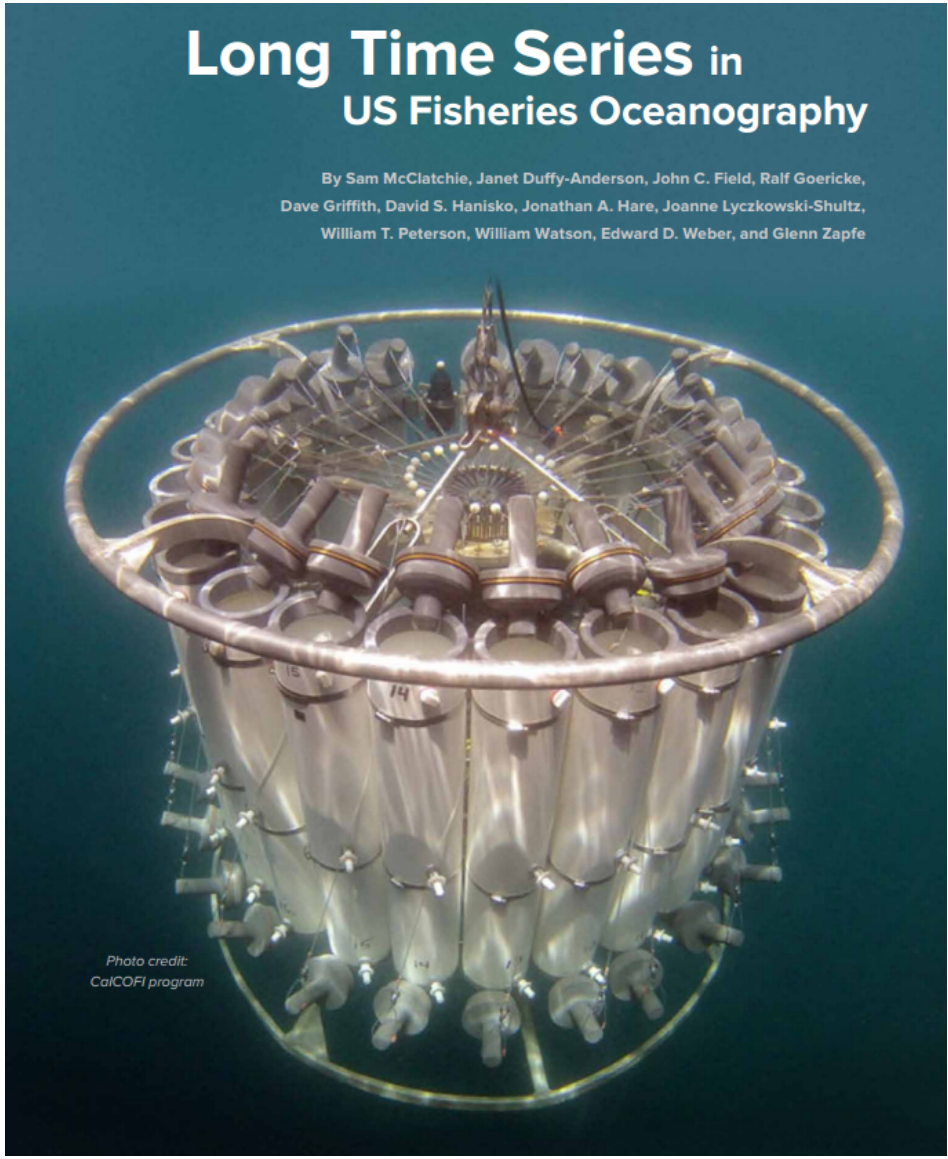


Relationship between sardine recruitment success and temperature. Upper and lower confidence intervals for the model fit are shown in *gray* (From Lindegren and Checkley [309])



Strengths, Challenges & Strategies

- Long time series track secular trends, provide estimates of variability, and provide reference levels for anomalous years.
- CalCOFI has virtually unparalleled, although not perfect, consistency, rigor and reliability.
- Core, quality-controlled datasets are provided to the broadest community via ERDDAP and through web summaries (e.g. hydrographic or CUFES maps).
- Peer-reviewed publications in a book, journals, and reports provide a program review, detailed research results, and detailed, validated survey methods.



Oceanography special issue on fisheries oceanography (2015)

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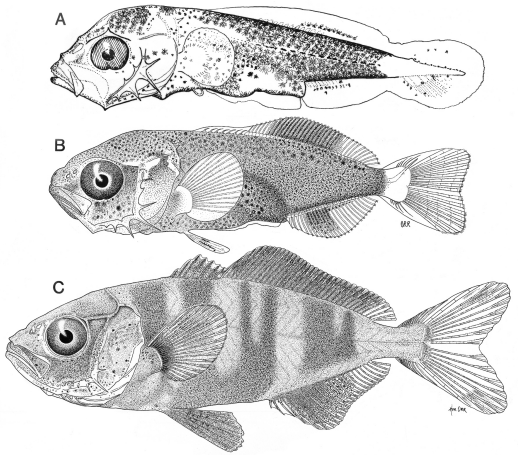
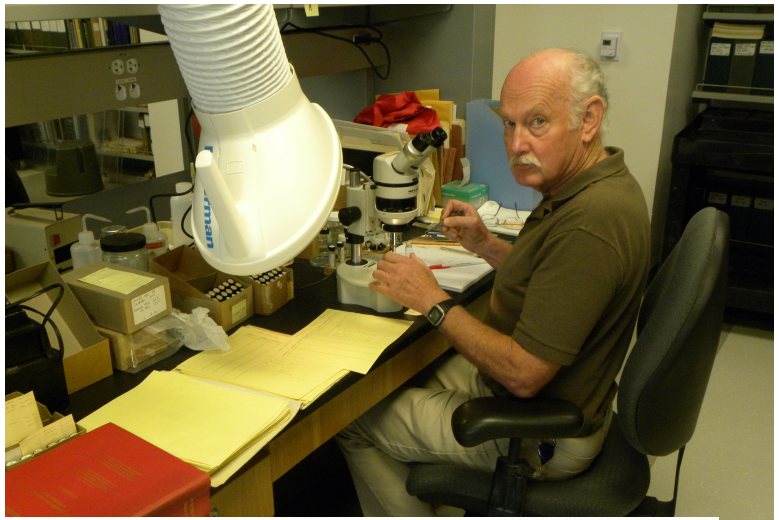
Strengths, Challenges & Strategies

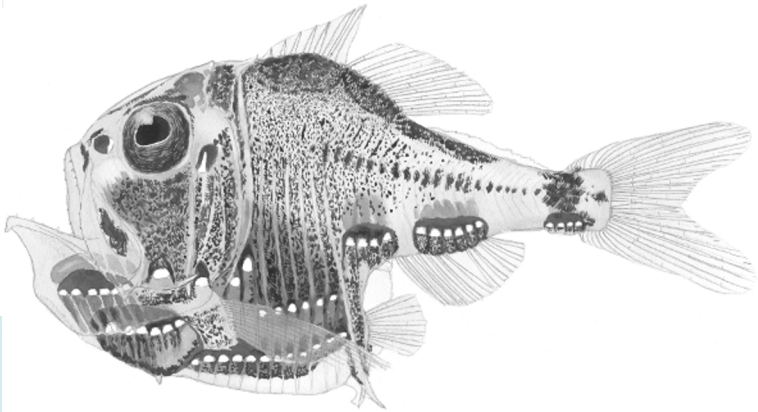
- How to provide sufficiently up to date information given current resourcing levels?
- Considerable CalCOFI data held by university and private researchers are still not public.
- How to increase efficiency without destroying time series?

Strengths, Challenges & Strategies



- Make subsets of data (e.g. spring time bongo net) available earlier to increase timeliness and relevance.
- Remove known roadblocks in the process (by funding more ichthyoplankton sorters, providing more young sea-going staff, and funding the redesign of the CalCOFI data systems).
- Use a carrot and stick approach with researchers who do not share CalCOFI data.
- Identify key data streams and determine which, if any, can be further automated to conserve vessel resources.





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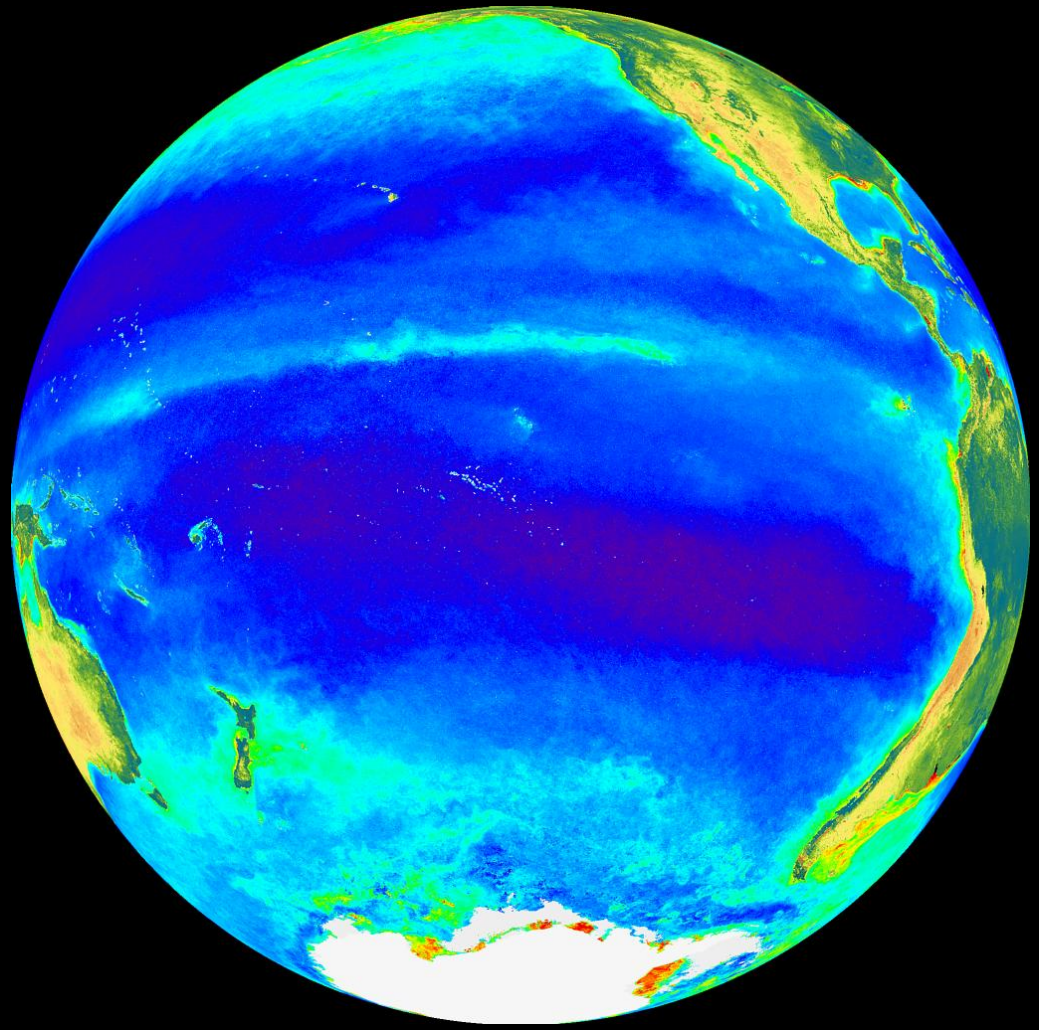

Questions?

Slides for anticipated questions follow …

CalCOFI data audit

CalCOFI											
Dataset	Type	Method	Start	End	Institu	Program	current PI/	Data Dep	Status	target delay	up to date until
ichthyoplankton (bongo, pairovet, m	vertical tows	count	1951	presen	SWFSC	NOAA-CalC	Watson	NOAA ERDD	data are accessible (400+ species, all stations,	1 year	2013
zooplankton volumes	oblique tows	count	1951	presen	SWFSC	NOAA-CalC	Watson	NOAA ERDD	data are accessible (all stations, all seasons)	1 year	2014
MOCNESS data	MOCNESS	count	1991	1993	SWFSC	NOAA	Watson	PC	embargoed for PhD thesis	n/a	n/a
MOCNESS data sensor data	ctd	count	1991	1993	SWFSC	NOAA-CalC	Watson	NOAA ERDD	data are accessible	n/a	n/a
CUFES fish egg data	CUFES	count	1996	presen	SWFSC	NOAA-CalC	Weber	SWFSC MSQ	data are accessible	3 month	2015
krill species data	bongo net	count	1951	presen	SIO	SIO-CalCOFI	Ohman	Brinton-Tow	data are accessible (3 species spring means)	?	2012
mesozooplankton carbon data	net	CHN analyser	1951	2005	SIO	SIO-CalCOFI	Ohman	DataZoo	data are accessible (spring means)	?	2005
copepod species data	net	count	1951	presen	SIO	SIO-CalCOFI	Ohman	?	no data available	?	?
gelatinous species data	bongo net	count	1951	2011	SIO	SIO-CalCOFI	Ohman	Datazoo	data are accessible (spring means)	?	2011
phyllosoma larvae data	bongo net	count	1951	2009	SIO	SIO-CalCOFI	Koslow	DataZoo	data are accessible (annual means)	n/a	2009
hydrographic profile data	CTD	ctd	1991	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2015
hydrographic bottle cast data	Bottle	discrete analysis	1949	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
oxygen	bottle	winkler	1949	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
phosphate	bottle	wet chemistry	1949	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
silicic acid	bottle	wet chemistry	1961	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
nitrate	bottle	wet chemistry	1969	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
ammonia	bottle	wet chemistry	2008	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
chlorophyll a	bottle	fluorometry	1977	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
inorganic carbon (TCO2, TAlk, pH)	bottle	various	2008	presen	SIO	SIO-CalCOFI	Dickson	CalCOFI.org	data are accessible	3 month	2014
primary productivity incubation data	bottle	14C-uptake into POC	1984	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
underway hull intake (T, S, fluoresce	underway	thermosalinograph	2004	presen	SIO	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2014
Underway currents	underway	ADCP	1993	presen	Hawaii	SIO-CalCOFI	Wilkinson	CalCOFI.org	data are accessible	3 month	2015
multifrequency acoustic data	underway	EK-60	2009	presen	SWFSC/	NOAA/ SIO	Demer/Chec	SWFSC AST	no data accessible	?	2014
Nordic trawl data	trawl net	count		presen	SWFSC	NOAA	Dorval	NOAA ERDD	data are accessible	3 month	2014
meteorological data	station	observations	1949	presen	SWFSC	NOAA-CalC	Griffith	CalCOFI.org	data are accessible	3 month	2014
pCO2	underway	underway IR meas	~ 2000	presen	SIO	CCE-LTER	PMEL	?		?	?
pCO2	underway	underway IR meas	~ 2000	presen	SIO	CCE-LTER	MBARI	?		?	?

CalCOFI data audit

CCE-LTER											
Dataset	Type	Method	Start	End	Institu	Program	current PI/	Data Depo	Status		up to date until
pCO2	underway	underway IR meas	~ 2015	presen	SIO	CCE-LTER	Martz	?	CCE-LTER since 2015. previous MBARI & PMEL	?	?
pH	underway	underway electroc	~ 2012	presen	SIO	CCE-LTER	Martz	DataZoo	no data accessible	?	-
dissolved C & N	bottle	high-temp combus	2004	presen	SIO	CCE-LTER	Aluwihari	DataZoo	no data accessible	?	-
particulate C & N	bottle	dry combustion	2004	presen	SIO	CCE-LTER	Goericke	DataZoo	data are accessible		2012
production of dissolved organic carb	bottle	14C-uptake into DOC	2004	2010	SIO	CCE-LTER	Goericke	DataZoo	no data available	?	-
phytoplankton community (Chl a size	bottle	Chl size-fractionat	2004	presen	SIO	CCE-LTER	Goericke	DataZoo	data are accessible		2010
phytoplankton community HPLC	bottle	HPLC	2004	presen	SIO	CCE-LTER	Goericke	DataZoo	no data available	?	-
phytoplankton fluorescence (active,	underway	Advanced Laser Fl	2011	persen	SIO	CCE-LTER	Goericke	DataZoo	no data available	?	-
microbial diversity	bottle	rDNA sequencing	2004	presen	SIO	CCE-LTER	Allen	?	retrospective work just begun	?	-
microbial gene expression	bottle	mRNA sequencing	2004	presen	SIO	CCE-LTER	Allen	?	retrospective work just begun	?	-
bacteria & picoautotrophs	bottle	flow cytometry	2004	presen	SIO	CCE-LTER	Landry	DataZoo	data are accessible	?	2012
nano- & microplankton	bottle	microscopy	2004	presen	SIO	CCE-LTER	Landry	DataZoo	data are accessible	?	2011
microplankton	bottle	microscopy	1996	presen	SIO	CCE-LTER	Venrick	?	held by Venrick	2 years	2012
mesozooplankton, optical size classe	net	OPC, LOPC	?	presen	SIO	CCE-LTER	Checkley	DataZoo	no data available	?	-
mesozooplankton, sentinel species	net	microscopy, ZOOS	2004	presen	SIO	CCE-LTER	Ohman	DataZoo	no data available	?	-
mesopelagic fish	trawl net	MOH-trawl	?	?	SIO	CCE-LTER	Koslow	DataZoo	no data available	?	-
mesopelagic fish	underway	EK-60	?	presen	SIO	CCE-LTER	Koslow	SIO Library	same as 'multifrequency acoustic data' above	?	

Other											
Dataset	Type	Method	Start	End	Institu	Program	current PI/	Data Depo	Status		up to date until
surface drifters	autonomous	deployment	2014	presen	NOAA/	Global Drift	Centurioni	?	?	real time	?
APEX drifters	autonomous	deployment	2015	presen	NAVOC	APEX Progra	Toon	Argo databa	data are accessible	real time	2015
seabirds	underway	visual observers	1987	presen	SIO, Far	CC Seabird	Sydemann	DataZoo	data are accessible (4 species)	?	2008
marine mammals	underway	visual observers		presen	SIO	CC Marine M	Hildebrand	DataZoo	no data available	?	
marine mammals	underway	acoustics		presen	SIO	CC Marine M	Hildebrand	?	?	?	
d13C & d15N of POM	bottle	mass spectrom.	2004	presen	UCSD		Keen	PC	not accessible	?	